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Organization and Operation of Urban Telephone Networks

Organizatsiya i Eksploatatsiya Gorodskikh Telefonnykh Setey

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Soviet telephone communication has four basic aspects: urban, inter-urban, suburban and intra-rayon.

Urban telephone communication embraces the comparatively small area of a town or population center where calls are quickly realized by subscription and pay telephones.

Intra-urban telephone communication connects republic, kray, oblast, and rayon centers through inter-urban telephone exchanges united by long distance lines. A high cost of installation and operation distinguish long distance lines. Calls are made on the basis of the "order" system, or if a sufficiently large number of channels are available, on the basis of the "immediate" system. The cost of a long distance call is figured on the basis of the duration of the call and the distance between callers.

Suburban telephone communication connects the largest centers of the country with their suburban rayons. The system of operation depends upon the extent and number of suburban lines. If there are a sufficient number of suburban lines and they are spread over a small area, the operations of urban and suburban telephone communication are identical. In this case, they are organized into one network.

Intra-rayon telephone communication embraces the territory of an administrative rayon and connects institutions, enterprises, and inhabitants with each other as well as with the rayon center. The low number of telephones per unit area and the length of telephone lines distinguish intra-rayon from urban telephone communication.

Even though the four aspects of telephone communication have different equipment and systems of operation, they must not be considered independent parts. Each urban, or intra-rayon and inter-urban main route is considered part of one system of telephone communication. The Soviet economy seeks the combined utilization of all means of communication.

The greatest differences exist between urban and inter-urban telephone communication. Differences in the size of the areas covered by them call for differences in construction and principles of organization and operation.

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In view of their technical and economic peculiarities, urban and inter-urban telephone communication are considered separately. The concern here is with urban telephone communication. (See diagram 1) The two types of telephone exchanges employed in urban telephone networks are the manual exchange (RTS), and the automatic exchange (ATS).

The manual exchanges are divided into those operating on a local battery system (MB), and those operating on a central battery system (TsB).

Manual exchanges are used in networks serving a small area with a capacity of 400 to 2,000 numbers, because they are economically feasible. The use of operators for less than 400 numbers is inexpedient, particularly at slack periods. RTS are also unsuitable for networks with a capacity of more than 2,000 numbers, because local exchanges and sub-exchanges are then installed. At the present time, RTS are being built in rayon centers and towns subordinate to oblasts.

RTS operating on the MB system are used in small settlements which lack a steady supply of electric energy. They are equipped with cabinet type switchboards which have a capacity of 50-100 numbers, and desk type switchboards which have a capacity of 30 numbers. Telephone exchanges operating on the TsB system are equipped with TsB x 2 switchboards. Although these switchboards are distinguished by simplicity of construction, they have a number of shortcomings. No more than 100 subscribers' telephone sets can be connected with the working place of one telephone operator. Telephone transmission is impaired by the uneven current supply of microphones which occurs when telephone sets are connected through subscribers lines of different length. In calling a number, the inter-urban telephone operator is compelled to cut it off without warning, if it is busy with a local call. A new type of TsB switchboard has been worked out to overcome these shortcomings.

The basic type of exchange employed in urban telephone communication is the automatic exchange (ATS). Its introduction enlarged the possibilities

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for developing urban telephone communication. Automatic telephone systems are constructed on the basis of three basic principles: 1) the step-by-step system whereby a step-by-step switch moves in immediate response to pulses sent in dialing a number; 2) the accumulation of pulses in a director which controls the movement of the switch with a driving machine; 3) the bypass principle which makes use of a relay type device; after a number is dialed it is first selected and later a connection is established directly between the caller and the party being called.

Step-by-step ATS are built primarily on the basis of using a ten-step switch. Originally the ten-step system was characterized by the small utilization of sets and not permitting a sufficiently flexible construction of telephone networks. Soviet industry has developed it to the point however, where it can be used on small and large telephone networks. It has become a universal system.

The machine system (mashinnaya sistema) is only suitable for comparatively large networks, sicne it is more complicated than the step-by-step system. The bank has a capacity of 500 lines and consists of 25 radially stringed frames with 20 lines each, which make up a bank for a group of 40-60 selectors. A motor-driven machine drive, consisting of a horizontal and a vertical drive shaft, moves the selector in two directions. A sender controls the movements of the selector.

In large cities the newly-introduced ten-step system operates beside the machine ATS installed earlier. Up to this time, technical problems have prevented the operation of two systems together on the same network. Now Soviet specialists have worked out a system of two-way automatic communication between subscribers of machine and ten-step exchanges.

Automatic exchanges have increased from 0 to 1927 to 36.1 percent of the total number of exchanges in 1940; correspondingly the percentage of manual exchanges decreased from 100 in 1927 to 63.9 in 1940. The postwar Five-Year Plan foresses the growth of urban telephone networks and an increase in their capacity on the basis of installing ten-step automatic

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telephone exchanges. The capacity of automatic telephone exchanges has been more than doubled since the beginning of the plan. The planned construction of city telephone networks was surpassed. In the course of 1947 alone, 67 new urban telephone exchanges were built, 33 of which were ATS. New ATS were built in Odessa, Stalingrad, Voronezh, Tula, Kalinin, Ul'yanovsk, Vladivostok, and other towns.

In building city telephone lines, use is made of overhead wires suspended from poles and supports, overhead telephone cables suspended from poles and supports, and underground cables laid in a special telephone conduit, or simply in the ground (armored cable).

Local conditions, including the number of subscribers, the density of the network, and the tempo of its growth determine the selection of the type of line construction.

Overhead lines are used for networks with a capacity of 50 - 100 numbers with comparatively little utilization of overhead telephone cables. Cables are only used on the terminal sections of the lines and on the lead in cable at the exchange.

Underground cables laid in conduits are used when the capacity of a network is increased. Overhead lines remain at the terminal points of lines and in areas of town where the number of subscribers is small. All types of line constructions can be seen in one urban telephone network.

Overhead wires are used if their number is small, not more than 20 at any rate. Overhead or underground cables can be used if the number of wires is larger. Overhead cables are used for those areas where streets and highways have not been planned finally, or a change is likely. Overhead cables are used to connect a group of subscribers, consisting of no more than 100, who are a considerable distance from the exchange.

Underground cables laid in conduits are primarily used in the construction of urban telephone networks. They are the most durable, reliable, and can be expanded most easily.

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The use of porcelain for terminal fittings to protect the cable from deterioration is unsatisfactory, and a plastic fitting has been worked out. The latter is attached to the cable at a plant, or regular workshop.

To reduce the cost of operation, urban telephone networks are divided into districts, each of which has an exchange (see diagram 2). Statistics show that the average use of a subscriber's line is only 2-5 percent of a 24-hour period. At the same time, the cost of line installations of this equipment is 60 percent alone of the costs of the whole network. The use of connecting devices between a group of subscribers is about 20-25 percent. Connecting installations for groups of subscribers are therefore cheaper than the equipment required for subscriber lines. Dividing a network into districts cuts the average length of the subscribers lines and reduces the amount of individual equipment in a network. Lines between exchanges enable subscribers in different districts to be connected and to have a higher rate of utilization.

Another method of reducing unused subscribers equipment is to connect two or more subscribers with one line. The load of a private line is only 0.5 percent in a 24-hour period. To raise the utilization of equipment, party lines and small group installations for 10-20 subscribers are used.

The hourly use of connecting lines and devices depends upon the structure of the trunk groups in which they are collected. The hourly utilization grows with an increase in the number of lines in a trunk group. It is evident that large trunk groups of connecting lines should connect district exchanges with each other.

In the initial period of growth of the district networks of urban telephone networks when manual exchanges were used, they were immediately connected with each other. With a substantial number of district exchanges, a large number of trunk groups were formed, which included, however, a small number of lines. As a result, the connecting lines were used inadequately.

Trunk groups are economical when they include a large number of lines, that is when they connect a small number of exchanges each of which has

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a large capacity. Then the direct connection between exchanges becomes feasible. Such a direct connection is not feasible if there are a large number of small exchanges in a network. In this instance, the district exchanges must unite the trunk groups of outgoing and incoming trunks. This can be done in a number of ways.

Telephone exchanges of small capacity can be connected with the closest district exchange. The connection between exchanges of small capacity then passes through a district exchange. Separate sections of the lines, from one exchange to the other, for example, are integrated with the connection of the district exchange. Consequently there are general trunk groups for these sections which eliminate the need for separate trunk groups for each exchange with a small capacity. Special devices (district circuit breakers) allow direct connections between numbers of the same exchange without loading the connecting lines to the district exchange.

Since the decentralization of exchange equipment reduces the expenses for line installations, small telephone exchanges are used in those urban districts where there are separate concentrated groups of 100 to 1,000 subscribers. Such small telephone exchanges, which belong to the district exchanges, are called sub-exchanges.

In large urban networks, trunk groups not only join or combine sub-exchanges but also district exchanges. Every network is divided into districts with several exchanges (up to ten), and a main or tandem central office is installed in each district. Thanks to these main district exchanges, the connections between all exchanges are integrated.

The first group selectors of all exchanges are installed in tandem central offices for the unification of the outgoing connection. All outlets of levels of the same name are collected into the general trunk groups to all the exchanges of the network. The unification of the outgoing connection occurs at the exchange of the central tandem office and the unified connection passes already from the central tandem office to the

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other exchanges by a general trunk group. Consequently the section between the central tandem office and the district exchange must have larger trunks. However, under such circumstances the exchanges of the so called tandem contral office of outgoing connection cannot complete an internal connection without the tandem office. Selector-repeaters are therefore necessary. Such a method complicates the equipment of all district exchanges considerably and is not therefore widely used.

The unification of trunks of incoming connection is more widely applied. The connection of each exchange to a definite group of other exchanges, which must all be connected to one incoming tandem central office, is collected in one trunk. If the trunks are unified in this way, the first group selectors remain in the district exchanges themselves and the selector-repeaters need not be installed. The connection from each exchange can be closed in the exchange itself with a series of other exchanges apart from the tandem office. Instead, the introduction of a new stage of selection is necessary for the incoming tandem office for the selection of district exchanges with 10,000 numbers. Therefore incoming tandem officexs are used for networks with a great capacity, when the introduction of a new level of selection is necessary because the capacity of the network is being increased. The partial introduction of incoming tandem offices is not excluded in some instances.

The selection of the system of construction for the line sections of the subscribers is very significant in the organization of urban telephone networks. The telephone exchange of the subscribers' network is usually installed in the center of the telephone load. Two-wire lines connect the exchanges with the telephone sets.

The growth and changes which constantly occur in a telephone network raise the necessity of reserve lines which allow the inclusion of new subscribers and the readjustment of the old. Economic considerations require that the number and lenght of the reserve lines be as small as possible. As a result, the reserve lines are not laid to the telephone exchange, but limited as ~~much~~ much as possible to the ~~smallest~~ shortest distance.

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Different systems are used to connect the telephone sets of the subscribers with the telephone exchange. The most widespread is the cross-connecting terminal system in which the so called main cable runs from the exchange to a cross-connecting terminal. Small distribution cables run from the cross-connecting terminals to distribution terminals which are installed in buildings and houses, or in cross-connection boxes on racks and supports. Single pair cables are laid from the distribution terminals to the telephone sets, and overhead wires are suspended from the cable cross-connection boxed.

In the above system, the subscribers line part of the network is divided into three parts: the main route - from the exchange to the cross-connecting terminal; the distributive - from the cross-connecting terminal to the cross-connecting box; the subscribers section - from the cross-connecting box to the telephone set. This system has great flexibility for the inclusion of other lines.

A ~~periment~~ permanent telephone network operates on another system in accordance with its peculiarities. Every network has permanent subscribers, like government institutions and industrial enterprises, who use the telephone regularly and do not change their address. These subscribers are given ~~constant~~ permanent telephone cables which connect them directly with the exchange without passing through cross-connecting terminals. The reserve cables and the cross-connecting terminals then become unnecessary.

In the non-cross-connecting terminal system or multiple parallel connection system, the cross-connecting terminals are absent, and the cross-connecting boxes have either a direct or parallel connection with the main route cable. Under this arrangement, a part of the cable pairs are common for two cross-connecting boxes. Every 100 pairs of the telephone cables, going from the exchange are distributed into 150 pairs in the distributive cross-connecting boxes without the intervening cross-connecting terminals.

The classification of urban telephone networks is necessary for organizing the administration and planning production. All telephone networks

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are divided into two large groups: a) networks with a capacity of 1,200 numbers and more as well as those located in oblast centers regardless of their capacity; b) all remaining networks with a capacity of less than 1,200 members.

Separate telephone networks make up the first group. A separate urban telephone network is an independent productive enterprise with its own productive-financial plan, an account in the Gosbank, and an independent balance. Such networks are subordinate to the chief of the oblast or kray administration of communications. Telephone networks of the second group are a part of the rayon offices of communications.

Separate telephone networks are divided into four classes according to their capacity. Networks with a capacity of 10,000 numbers or more belong to class I, with 5,000 to 10,000 numbers to class II, with 2,400 to 5,000 numbers to class III, and with 1,200 to 2,400 numbers to class IV.

The division of networks on the basis of capacity alone is incomplete, since it does not include the type of network, the system of exchange etc. A distinction is made between those networks which have been divided into districts and those which have not, been those of different capacities, and between those with different exchanges.

Networks which have not been divided into districts can be equipped with RTS and ATS exchanges. They are divided into three classes according to the make-up of their equipment and capacity, with up to 1,000 numbers one class, 1,000 to 3,000 in a second, and 3,000 to 10,000 in a third.

Networks which have been divided into districts are only equipped with automatic exchanges. They are divided into three classes with up to 10,000 numbers in one, 10,000 in a second, and anything more than 100,000 in a third.

All telephone networks must be divided into four classes. Networks with a capacity of more than 100,000 numbers must be considered outside a class. (see diagram No 3)

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Diagrams

1. Skeleton diagram of urban telephone network. See page 49 of the Russian source. The English translation of the Russian legend is as follows:

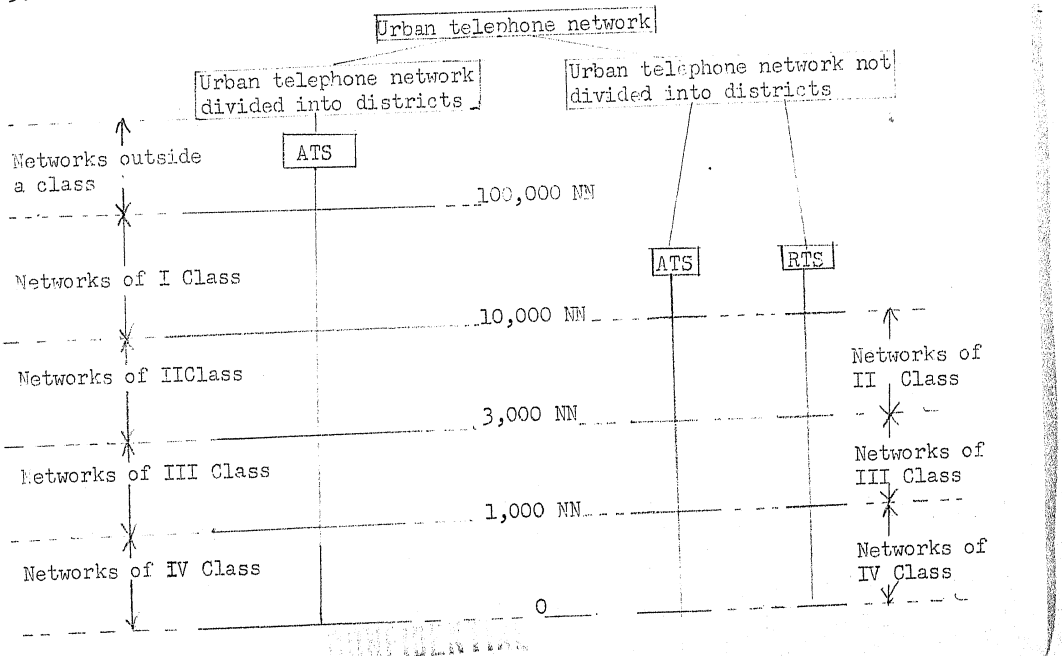
Inter-urban channels ⟷ Inter-urban channels

- Urban telephone exchange
- Inter-urban exchange
- Intra-rayon telephone exchange
- Institutional (Private) telephone exchanges
- Intra-rayon tandem central office
- Intra-rayon satellite exchange
- Subscriber's telephone
- Urban services (emergency and fire brigade)
- Auxiliary services of telephone network
- Pay phone

2. Diagram of urban telephone network divided into districts. See page 37 of the the Russian source. The English translation of the Russian legend is as follows:

- Central telephone exchange
- District telephone exchange
- Subscriber's telephone
- Trunk

3. Classification of urban telephone network.



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